ROMS Tangent Linear and Adjoint Models: Testing and Applications

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LONG-TERM GOALS

Our long-term technical goal is to produce a tested tangent linear and adjoint model for ROMS (Regional Ocean Modeling System) that is suitable for general use by ROMS modelers. This is complementary to the Kalman Filter, ESSE, and Green's Functions techniques being developed in other contexts. Our long-term scientific goal is to model and predict the mesoscale circulation and the ecosystem response to physical forcing in the various regions of the world ocean through ROMS primitive equation modeling/assimilation.

OBJECTIVES

We seek to develop an adjoint model for the Rutgers/UCLA Regional Ocean Modeling System (ROMS) which is a parallel/improved physics descendent of the serial SCRUM (Song and Haidvogel, 1994). We also seek to complete the assimilation system by including the adjoint in an estimation procedure for fitting the model to data. The resulting codes will be suitable for general use in any geometry of ROMS, which presently lacks an adjoint.

APPROACH

This is fundamentally a collaborative effort involving University of Colorado (A. Moore), Rutgers (H. Arango) and Scripps (B. Cornuelle, Ph. D. student E. Di Lorenzo, A. Miller, and D. Neilson). Our approach is to write the tangent linear and adjoint models for ROMS by hand. With each participant in the project contributing expertise in coding and model testing, the approach is feasible. Once the development is accomplished, the assimilation scheme will be tested in various scenarios involving observations. The Scripps contingent will test the adjoint for ROMS in the California Current CalCOFI region where they are presently applying ROMS

(under NASA funding) to a physical-biological data synthesis and a model forecast scenario. Arango and Moore will test the adjoint in the Mid-Atlantic Bight(under NSF funding) for coupled atmosphere-ocean hindcast experiments using data collected at the observational network centered at the Long-Term Ecosystem Observatory (LEO-15).

WORK COMPLETED

The ROMS adjoint team met several times over the past year in intensive tangent linear and adjoint model writing/testing sessions. A working 2D tangent linear and adjoint model is now running and being used to compute optimal perturbations (Moore and Farrell, 1994) to study the model error growth. The optimal perturbations are computed by a forward integration of the tangent linear equations followed by an integration of the result backwards in time using the adjoint equations. A large percentage of ROMS 3D routines are now completed, but not yet tested.

RESULTS

The building of the adjoint is largely a technical task. Many scientific technical results will follow once the codes are ready.

IMPACT/APPLICATIONS

Users of the tangent linear and adjoint model for ROMS will have a powerful tool for exploring data assimilation issues that include sensitivity to initial conditions and surface forcing, predictability and ocean dynamics.

TRANSITIONS

The work completed here will be part of the ROMS (and in the future, TOMS) utilities that will be freely available to all interested users.

RELATED PROJECTS

Moore, Arango, Miller and Cornuelle will soon commence a project funded by NSF (lead PI: A. Bennett, NPS/OSU) entitled "Modular Ocean Data Assimilation". The goal is to use the infrastructure of the Inverse Ocean Modeling System of Chua and Bennett (2001) in conjunction with the ROMS tangent linear and adjoint models for ocean data assimilation. Miller and Cornuelle are funded by NASA to explore Green's Functions model fitting techniques (Miller and Cornuelle, 1999) with ROMS in the Southern California Bight of the California Current System http://osep.ucsd.edu/index.cgi?rsadjoint. Those results will prove useful in comparing with results from applying the adjoin t to these same data.

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